CLAIMS

I claim:

1. An acoustic sensor comprising:

a laminate including a piezoelectric transducer element having first and second faces, the laminate further including a composite backing layer deployed on the first face of the transducer element;

the transducer element including conductive electrodes disposed on the first and second faces thereof; and

the composite backing layer including at least one powder material disposed in an elastomeric matrix material.

2. The acoustic sensor of claim 1, wherein the at least one powder material comprises at least one tungsten powder.

3. The acoustic sensor of claim 1, wherein the at least one powder material comprises first and second tungsten powders, the first tungsten powder having an average particle size greater than that of the second tungsten powder.

4. The acoustic sensor of claim 3, wherein:

the first tungsten powder has an average particle size ranging from about 2 to about 4 microns; and

the second tungsten powder has an average particle size ranging from about 10 to about 18 microns.

5. The acoustic sensor of claim 1, wherein the elastomeric matrix comprises a fluoroelastomer material.

6. The acoustic sensor of claim 5, wherein the fluoroelastomer material comprises about 66 atomic percent fluorine.

7. The acoustic sensor of claim 5, wherein the fluoroelastomer material comprises about 68 atomic percent fluorine.

8. The acoustic sensor of claim 5, wherein the fluoroelastomer material comprises about 70 atomic percent fluorine.

9. The acoustic sensor of claim 5, wherein the fluoroelastomer material includes a copolymer of vinylidene fluoride and hexafluoropropylene.

10. The acoustic sensor of claim 5, wherein the composite backing layer further comprises at least one acid accepter selected from the group consisting of magnesium oxide, calcium hydroxide, litharge, zinc oxide, dyphos, and calcium oxide.

11. The acoustic sensor of claim 5, wherein the composite backing layer further comprises at least one carbon black filler.

12. The acoustic sensor of claim 5, wherein the composite backing layer further comprises at least one mineral filler selected from the group consisting of barium

sulfate, calcium silicate, titanium dioxide, calcium carbonate, diatomaceous silica, and iron oxide.

13. The acoustic sensor of claim 5, wherein the composite backing layer is a product of the process comprising:

dissolving the fluoroelastomer material in a liquid solvent;

mixing one or more tungsten powders into the solvent;

substantially evaporating the solvent to form a specimen of fluoroelastomer composite material; and

forming the composite backing layer by hot pressing the specimen into a pellet shape.

14. The acoustic sensor of claim 1, wherein:

the at least one powder material comprises first and second tungsten powders, the first tungsten powder having an average particle size greater than that of the second tungsten powder; and

the elastomeric matrix material comprises a fluoroelastomer material including a copolymer of vinylidene fluoride and hexafluoropropylene.

15. The acoustic sensor of claim 14, wherein the composite backing layer further comprises:

at least one acid accepter selected from the group consisting of magnesium oxide, calcium hydroxide, litharge, zinc oxide, dyphos, and calcium oxide;

at least one carbon black filler; and

at least one mineral filler selected from the group consisting of barium sulfate, calcium silicate, titanium dioxide, calcium carbonate, diatomaceous silica, and iron oxide.

16. The acoustic sensor of claim 15, wherein the composite backing layer is a product of the process comprising:

blending the fluoroelastomer material with the at least one acid acceptor, the at least one carbon black filler, and the at least one mineral filler to form a fluoroelastomeric blend;

dissolving the fluoroelastomeric blend in a liquid solvent;

mixing the first and second tungsten powders into the solvent;

substantially evaporating the solvent to form a specimen of fluoroelastomer composite material; and

forming the composite backing layer by hot pressing the specimen a pellet shape.

17. The acoustic sensor of claim 1, further comprising an additional backing layer disposed adjacent the composite backing layer, the additional backing layer having a negative coefficient of thermal expansion.

18. The acoustic sensor of claim 17, wherein the additional backing layer comprises a ceramic material.

19. The acoustic sensor of claim 17, wherein the composite backing layer is interposed between the transducer element and the additional backing layer.

20. The acoustic sensor of claim 1, wherein the transducer element comprises a piezo-ceramic transducer element.

21. The acoustic sensor of claim 1, wherein the transducer element comprises a piezo-composite transducer element.

22. The acoustic sensor of claim 1, wherein the laminate further comprises at least one matching layer deployed on the second face of the transducer element.

23. The acoustic sensor of claim 1, wherein the laminate further comprises a metallic barrier layer deployed on an outermost surface of the laminate proximate the second face of the transducer element.

24. A downhole measurement tool comprising:

a substantially cylindrical tool body;

at least one acoustic sensor deployed on the tool body, the acoustic sensor including a piezoelectric transducer element having first and second faces, the transducer element in electrical communication with an electronic control module via conductive electrodes disposed on each of said faces; and

the acoustic sensor further including a composite backing layer deployed on the first face of the transducer element, the composite backing layer including at least one powder material disposed in an elastomeric matrix material.

25. An acoustic sensor comprising:

a laminate including a piezoelectric transducer element having first and second faces, the laminate further including a composite backing layer deployed on the first face of the transducer element and a matching layer assembly deployed on the second face of the transducer assembly;

the transducer element including conductive electrodes disposed on the first and second faces thereof;

the composite backing layer including at least one powder material disposed in an elastomeric matrix material; and

the matching layer assembly including at least one matching layer and a barrier layer, the barrier material including a metallic material, the at least one matching layer being deployed between the transducer element and the barrier layer.

26. The acoustic sensor of claim 25; wherein

the at least one powder material comprises first and second tungsten powders;

the matching layer assembly includes first and second matching layers, the first matching layer being deployed between the second face of the transducer element and the second matching layer, the first matching layer having an acoustic impedance in the range from about 8 to about 15 MRayl and the second matching layer having an acoustic impedance in the range from about 3 to about 7 MRayl; and

the barrier layer includes corrugated titanium.

27. A method for fabricating an acoustic sensor, the method comprising:

(a) providing at least one powder and at least one elastomeric material;

(b) mixing the at least one powder with the at least one elastomeric material;

(c) forming the at least one powder and the at least one elastomeric material into a composite backing layer; and

(d) deploying the composite backing layer on one face of a substantially planar piezoelectric transducer element.